

# Map Projection Definition

Snyder (1993) gives this definition; "*The systematic representation of all or part of the surface of a round body, especially the earth, onto a flat or plane surface is called a map projection.*"

Map Projections (USGS 2000) starts with the definition; "*A map projection is used to portray all or part of the round Earth on a flat surface*". There is another definition in a small glossary located at the end of this publication "*A map projection is a systematic representation of a round body such as the Earth on a flat (plane) surface*".

In the National Atlas of the United States, which since 2014 has no longer been directly available on the Internet, but can be found at another address (Wayback Machine 2014), map projections are defined in the following way: "*A map projection is a way to represent the curved surface of the Earth on the flat surface of a map.*"

These three definitions of map projections (Snyder 1993, USGS 2000, Wayback Machine 2014) are very similar. What is common to them all is that they are about mapping (systematic representation or a way to represent).

Mapping is one of the basic terms in mathematics. To recall, two non-empty sets,  $X$  and  $Y$ , are given. By mapping we understand the rule that each element  $x$  from  $X$  joins element  $y$  from  $Y$ . So, we write  $f: X \rightarrow Y$ . Element  $y$  is the image of  $x$ , so we write  $y = f(x)$ . Set  $X$  is the domain of mapping  $f$ , while set  $Y$  is codomain.

The difference between the three definitions of map projection is in the domain (*a round body or curved surface or surface of a round body*) and in the codomain (*a flat (plane) surface or flat surface or a flat or plane surface*).

Mathematicians differentiate between a body and a surface. Since map projections are mappings from a surface (*usually a sphere or ellipsoidal surface*) into a plane, a body should not be taken as the domain in the definition of map projection.

Furthermore, mathematicians differentiate between a plane and a flat surface. The plane is a fundamental concept in geometry; a flat surface in three-dimensional space, which expands to infinity in every direction. If it is flat, it means that an infinite number of straight-lines pass through each of its points, which it completely contains. Or "*A flat surface on which a straight line joining any two points on it would wholly lie.*" From another point of view, "*A regular surface and special class of minimal surface are flat surfaces if the Gaussian curvature vanishes everywhere. A tangent developable, generalized cone, and generalized cylinder are all flat surfaces*". (Weisstein 2017). From this, we can conclude that a plane and a flat surface are not synonyms. Moreover, since conical and cylindrical surfaces are flat surfaces, it would make sense in the definition of map projections for them to be taken as codomains too, if indeed the mapping was either on the cone or cylinder mantle, which is generally not the case. It would also be contrary to the explanation regularly encountered in the introduction of map projections, that the globe occupies a lot of space, is difficult to translate, is financially demanding to produce and update, and even the largest globe made to a very small scale shows relatively few details. Of course, everything said about globes in the form of spheres, such as those we are accustomed to, also applies to globes in the form of cones or cylinders. Consequently, a map is not displayed on a flat surface (a conical or cylindrical surface) but in a plane.

Let us look at the adjective *systematic* in some definitions of map projections. If a systematic approach is understood to mean "an approach that is methodical, repeatable and able to be learned by a step-by-step procedure", that is acceptable. However, the adjective can be used in a variety of ways, so it might be

better to replace it with planned or organized. If we keep the definition of map projection as a representation, then we need to give it an adjective to distinguish it from a photograph or another image. If we use mapping in the meaning of the mathematical term, then there is no need for another word.

To conclude, the domain of map projection should be a surface rather than a body. For the codomain of map projection, the concept of a plane rather than a flat surface should be used. Instead of representation it is better to say mapping, assuming that the concept of mapping is known from mathematics. It should be, because it has always been around in education. So why not use it, when it is so neatly linked to the word map?

The definition of map projection would then be as follows: *A map projection is the mapping of a curved surface, especially a sphere or ellipsoid, into a plane.*

## Literatura / References:

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# Definicija kartografske projekcije

Snyder (1993) ima ovu definiciju kartografske projekcije: "*The systematic representation of all or part of the surface of a round body, especially the earth, onto a flat or plane surface is called a map projection.*"

Publikacija Map Projections (USGS 2000) počinje definicijom "*A map projection is used to portray all or part of the round Earth on a flat surface.*" U malom rječniku koji se nalazi na kraju spomenute publikacije je ova definicija "*A map projection is a systematic representation of a round body such as the Earth on a flat (plane) surface.*"

U National Atlas of the United States, koji od 2014. više nije izravno dostupan na internetu, ali ga je moguće naći na drugoj adresi (Wayback Machine 2014) definirane su kartografske projekcije na ovaj način: "*A map projection is a way to represent the curved surface of the Earth on the flat surface of a map.*"

Prethodne tri definicije kartografskih projekcija (Snyder 1993, USGS 2000, Wayback Machine 2014) vrlo su slične. Ono što im je zajedničko je to da je svaki put riječ o preslikavanju (*systematic representation* ili *a way to represent*).

Preslikavanje je jedan od osnovnih pojmova u matematici. Podsjetimo se. Neka su zadana dva neprazna skupa  $X$  i  $Y$ . Pod preslikavanjem koje označavamo ovako  $f: X \rightarrow Y$  razumijevamo propis koji svakom elementu  $x$  iz  $X$  pridružuje element  $y$  iz  $Y$ . Element  $y$  zove se slika od  $x$  i pišemo  $y = f(x)$ . Skup  $Y$  zovemo područjem slike od  $f$  ili kodomenom od  $f$ , a skup  $X$  zovemo područjem originala ili područjem definicije od  $f$  ili domenom od  $f$ .

Razlika navedenih definicija kartografske projekcije (Snyder 1993, USGS 2000, Wayback Machine 2014) je u području definicije ili domeni (*round body* ili *curved surface* ili *surface of a round body*) i u području vrijednosti ili kodomeni tog preslikavanja (*a flat (plane) surface* ili *flat surface* ili *a flat or plane surface*).

Matematičari razlikuju tijelo (*body*) i plohu (*surface*). Budući da su kartografske projekcije preslikavanja neke plohe (najčešće sfere ili plohe elipsoida) u ravninu, to nije dobro za područje definicije kartografske projekcije uzeti tijelo.

Matematičari razlikuju ravninu (*plane*) i ravnu plohu (*flat surface*). Ravnina je jedan od osnovnih pojmova u geometriji, ravna ploha u trodimenzionalnom prostoru, koja se u svakom smjeru širi do beskonačnosti. Da je ravna, znači da kroz svaku njenu točku može biti povučeno beskonačno mnogo različitih pravaca, koje ona u potpunosti sadrži. Ili: "*A flat surface on which a straight line joining any two points on it would wholly lie.*" S druge strane "*A regular surface and special class of minimal surface for which the Gaussian curvature vanishes everywhere. A tangent developable, generalized cone, and generalized cylinder are all flat surfaces.*" (Weisstein 2017). Iz navedenoga možemo najprije zaključiti da ravnina i ravna ploha nisu istoznačnice. Nadalje, budući da se konusne i cilindrične plohe ubrajaju u ravne plohe imalo bi smisla u definiciji kartografskih projekcija uzeti kao područje vrijednosti preslikavanja i takve plohe kad bi zaista preslikavanje bilo na plašt konusa ili cilindra, što općenito nije slučaj. Ne samo to, već bi to bilo u suprotnosti s obrazloženjem koje se redovito susreće pri uvođenju kartografskih projekcija da su nedostaci globusa u tome što zauzima puno prostora, teško ga se prenosi, financijski je zahtjevna njegova proizvodnja i osuvremenjivanje te da je čak i najveći globus izrađen u vrlo sitnom mjerilu pa pokazuje relativno malo detalja. Naime, sve navedeno za globus u obliku sfere na kakav smo navikli, vrijedi naravno i za globus u obliku konusa ili cilindra. Prema tome, karta nije prikaz na ravnoj plohi (konusnoj ili cilindričnoj plohi) nego u ravnini.

Osvrnimo se još na pridjev *systematic* u nekim definicijama kartografskih

projekcija. Ako se pod sustavnim ili sistematskim pristupom podrazumijeva "*The approach that is methodical, repeatable and able to be learned by a step-by-step procedure*" onda bi to bilo u redu. Međutim, taj se pridjev može doživjeti na razne načine pa bi umjesto njega možda bolje bilo upotrijebiti pridjev planski (*planned*) ili organizirani (*organized*). Ako ostajemo kod definiranja kartografske projekcije kao prikaza (*representation*) tada mu moramo dati neki pridjev kako bismo ga razlikovali npr. od fotografije ili neke druge slike. Ako pak umjesto prikaza (*representation*) upotrijebimo preslikavanje (*mapping*) u značenju te riječi kakvo poznajemo iz matematike, onda nestaje potreba za dodatnim pridjevom.

**Kartografska projekcija je preslikavanje zakrivljene plohe, npr. sfere ili elipsoida, u ravninu.**

Zaključimo, za domenom ili područje definicije kartografske projekcije treba upotrijebiti pojam plohe, a ne tijela. Za kodomenom ili područje vrijednosti kartografske projekcije treba upotrijebiti pojam ravnine, a ne ravne plohe. Umjesto prikaza (*representation*) bolje je upotrijebiti preslikavanje (*mapping*) uz pretpostavku da je pojam preslikavanja (*mapping*) poznat/preuzet iz matematike. Pretpostavimo li da je pojam preslikavanja (*mapping*) poznat iz matematike, a trebao bi biti jer se pojavljuje već na početku školovanja, tada nema razloga da ga ne upotrijebimo. Uočimo da je u engleskom jeziku vrlo jasno povezan riječju karta (*map*).

Na taj način definicija kartografske projekcije glasila bi ovako: *Kartografska projekcija je preslikavanje zakrivljene plohe, npr. sfere ili elipsoida, u ravninu.*

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